An endangered species that is also a pest: a case study of Baudin's Cockatoo *Calyptorhynchus baudinii* and the pome fruit industry in south-west Western Australia

T F Chapman

Department of Environment and Conservation,
Locked Bag 104, Bentley Delivery Centre, Bentley WA 6983.
✉ tamra.chapman@dec.wa.gov.au

Manuscript received September 2006; accepted January 2007

Abstract

Baudin's Cockatoo *Calyptorhynchus baudinii* is an endangered species that is endemic to south-west Western Australia. It is also a declared pest of agriculture because it damages apple and pear (pome fruit) crops in commercial orchards. Although it is unlawful, some fruit growers shoot and kill the cockatoos to prevent fruit damage. A survey of pome fruit growers during the 2004/2005 season showed that shooting to kill can-not be justified in terms of the damage the cockatoos cause or the costs of damage control incurred by growers. Estimated loss of income to fruit damage by birds equated to 6% of farmgate income and the cost of damage control represented 2% of farmgate income. Damage levels varied significantly between individual properties and pink lady apple was the most commonly and severely damaged fruit variety. This study has shown that non-lethal scaring techniques are effective for protecting pome fruit from damage by Baudin's Cockatoo.

Keywords: Baudin's Cockatoo, *Calyptorhynchus baudinii*, pome fruit industry, Western Australia

Introduction

Baudin's Cockatoo (*Calyptorhynchus baudinii*), the long-billed White-tailed Black Cockatoo, has been known to damage fruit in apple and pear (pome fruit) orchards since the early 1900s (Halse 1986). In the past, the damage was managed by a number of lethal means via notices published in the Western Australian Government Gazette (Table 1). These means included government bonus payments for the destruction of the cockatoos and open seasons for shooting, in selected shires, when causing damage to fruit (Table 1).

This cockatoo, which is endemic to the south-west of Western Australia, may no longer be killed to protect fruit crops, because it has been listed as a threatened species since 1996. Using IUCN (1994) Red List Categories and Criteria, Baudin's Cockatoo is listed as Endangered in Western Australia and Vulnerable Nationally. Illegal killing of these cockatoos continues (CALM 2005) and, along with habitat loss and competition for nest hollows with feral honeybees, illegal shooting to protect pome fruit crops is one of the principal threats to the population (CALM 2006).

Presumably, those fruit growers who shoot the cockatoos do so because they believe: the cockatoos are the principal pest of pome fruit crops; the damage the cockatoos cause results in significant loss of income; the cost of non-lethal crop protection is excessive; and non-lethal techniques, such as scaring, are not effective or not cost effective. The purpose of this study was to assess the validity of these perceptions via a grower survey.

A grower survey was conducted during and after the 2004/2005 pome fruit season. The purpose of the survey was to assess the attitudes of the growers toward the conservation status of the cockatoo and to assess the cost of damage and damage control to growers. Data on the damage control methods employed by growers were collected to assess the effectiveness of the non-lethal techniques employed.

The limitations of grower surveys versus quantitative measurements have been discussed elsewhere (*e.g.* see Bomford and Sinclair 2002) and so will not be discussed in detail in this paper. Although grower surveys may be limited by the skill, honesty and motivation of the participants, they do provide an overview and would be expected to represent the experiences of the growers across the industry.

Materials and Methods

A survey of fruit production, fruit damage and damage control efforts was prepared by the author, based on other studies of bird damage (*e.g.* Lim *et al.* 1993), and in consultation with the Executive Manager of the Western Australian Fruit Growers' Association (WAFGA). The survey was posted to all 277 fruit growers registered as apple and pear growers with WAFGA in May 2005. The survey was confidential, but respondents were asked to provide contact details to clarify the data provided. The growers were provided with a reply paid envelope to encourage them to return the surveys and members of the Warren Catchments Council assisted by collecting surveys in person. A space allowing growers to make written comments was provided at the end of the survey.

Table 1

Summary of changes to the pest and conservation status of Baudin's Cockatoo in Western Australia over time.

Time period	Pest and conservation status	Reference
1950s and 1960s	Bonuses or bounties paid by Bridgetown Shire.	Whittell (1950) and Saunders (1974)
1978	May be taken when causing damage to fruit.	WA Govt Gazette, June 16, 1978
1980	Numbers to be controlled and/or reduced in the Shires of Denmark, Donnybrook and Plantagenet	WA Govt. Gazette, 12 December 1980
1988	A management program outlines the conditions under which controls for Baudin's Cockatoo be applied	WA Govt. Gazette, 09 December 1988
1989 to present	Killing of Baudin's Cockatoo to protect fruit crops (or for any reason) is an offence under the provisions of the Western Australian *Wildlife Conservation Act 1950.*	WA Govt Gazette, 19 May 1989
1996 to present	Listed as a threatened species (Endangered using IUCN (1994) Red List Categories and Criteria), under the provisions of the Western Australian *Wildlife Conservation Act 1950.*	WA Govt Gazette, 30 April 1996

The survey asked growers if they knew Baudin's Cockatoo is endangered and if they thought it should be protected, even though it damages fruit crops. They then listed their top five bird pests in the order of the damage they cause, from 1–5 most to least damage. The survey asked if growers had ever had a problem with Baudin's Cockatoo damaging their fruit crop and if Baudin's Cockatoo had damaged their crop in the last 12 months. The monetary cost of damage to the fruit by birds during the 2004/2005 season (in terms of loss of farmgate income) was estimated by growers.

A table was provided for growers to fill in their crop type(s) (apple or pear), variety of fruit and the area of planting (ha) and the number of trees for each variety. The months in which damage occurred was recorded and the extent of the damage was ranked from (1): None to (6): Extreme against each variety. The categories of damage were modelled on those used by Lim *et al.* (1993) and modified in consultation with WAFGA, based on the percentage of fruit lost.

The survey asked growers if they had previously used pest control to stop Baudin's Cockatoo damaging their crop. If they had previously used pest control, growers filled in a table of the number of days and hours per day damage control was undertaken during the 2004/2005 season and the cost of damage control per hour (including wages and consumables). These data were used to calculate the total cost of damage control for the 2004/2005 season.

A table of commonly used damage control techniques was provided and growers were asked to rate the effectiveness of the techniques from (a): Not effective to (e): Highly effective, against each of the techniques they used to protect crops from damage by Baudin's Cockatoo. For those growers who had used a combination of damage control techniques, the effectiveness of these was categorised into the same ratings of effectiveness. Space was made available for growers to list and rate 'other' damage control techniques that were not shown on the survey.

The damage caused by various pest bird species, severity of damage to each fruit variety and the effectiveness of damage control techniques (as shown in the figures) were ranked from highest to lowest using the following weighted calculation (after Lim *et al.* 1993):

$$\text{Index} = \sum \frac{(n_1 \times 1) + (n_2 \times 2) + (n_3 \times 3) \ldots\ldots\ldots.(n_6 \times 6)}{n_t} \times \frac{100}{C}$$

Where $n_{1\text{-}6}$ = number of responses for each category, n_t = total number of responses and C = highest category assessed.

All statistical analyses were carried out using JMPIN software (SAS Institute 1996) in accordance with the software instructions (Sall & Lehmann 1996). An ANOVA model was used to examine the relationship between the proportion of fruit damaged and individual properties, shire in which the property was located, crop variety, plantation area, number of trees in the plantation and tree density. Each property was treated as a sampling unit, and property was nested in Shire to prevent repeated analyses of the same data. The data met the assumptions of the test and so did not require transformation. A *post-hoc* Dunnett's Tests ($p < 0.05$) was used to group apple varieties on the basis of proportion of fruit damaged (Sall & Lehmann 1996). Only the three most commonly grown varieties were used in the analysis due to lack of data for the remaining varieties.

Results

Of the 277 surveys that were posted to fruit growers registered as apple and pear growers with the WAFGA in May 2005, 86 (31%) were returned. Five further surveys were returned unopened because the growers either no longer resided on the property or had removed all their pome fruit trees. Since not all survey participants responded to all questions in the survey, the number of responses to each question is shown in the parentheses, after the percentage values, in the text below. Also shown is the sampling error for each response (confidence interval 95%).

The top ranked pest bird species of apple and pear crops were Baudin's Cockatoo, the Australian Ringneck (*Platycercus zonarius semitorquatus*) and the Red-capped Parrot (*Platycercus spurius*) (Figure 1). The majority of growers (72% ± 7.9%, $n = 86$) said they knew

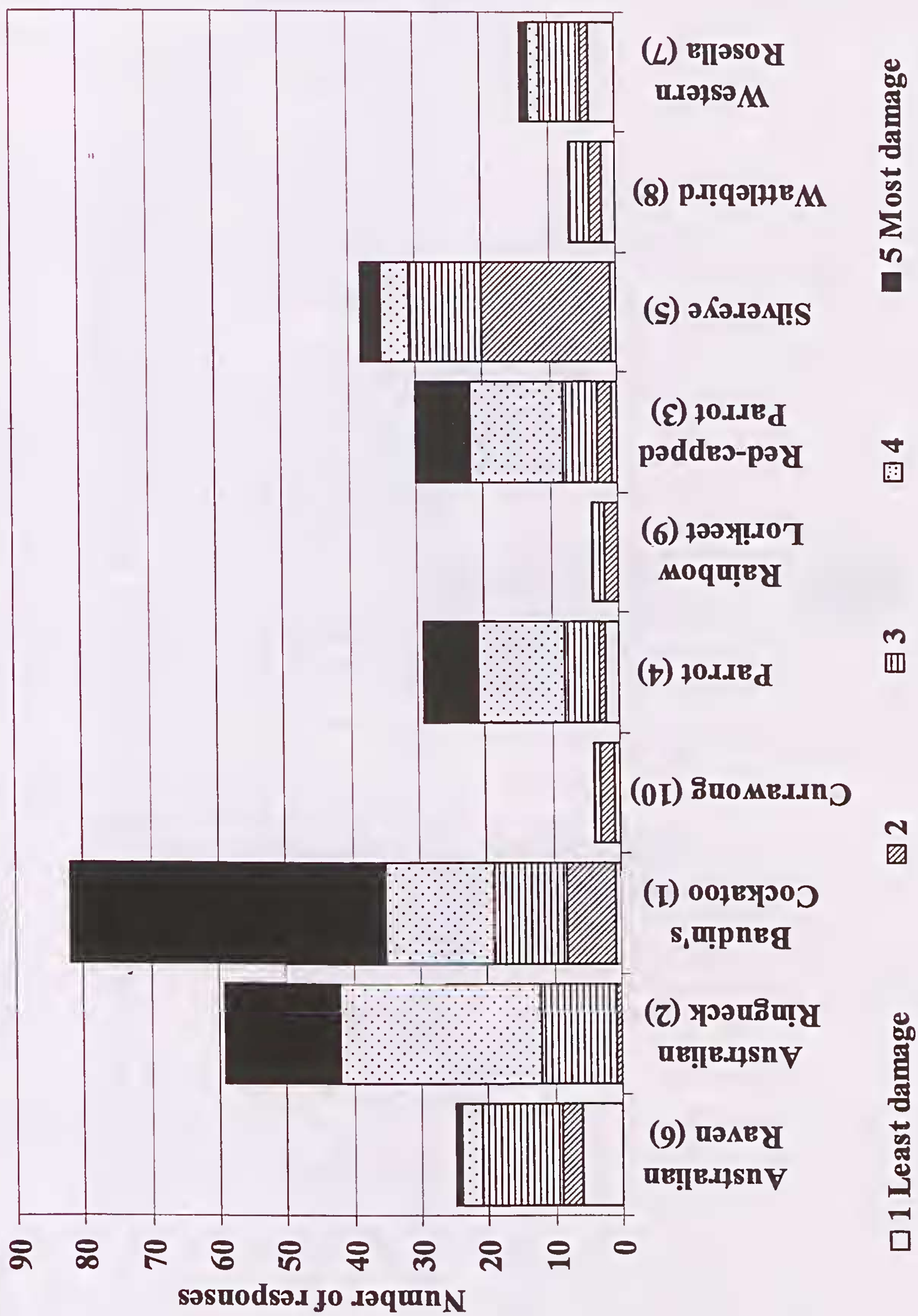

Figure 1. Pest birds of pome fruit crops in south-west Western Australia ($n = 292$). Values in parentheses show ranking by relative extent of the damage.

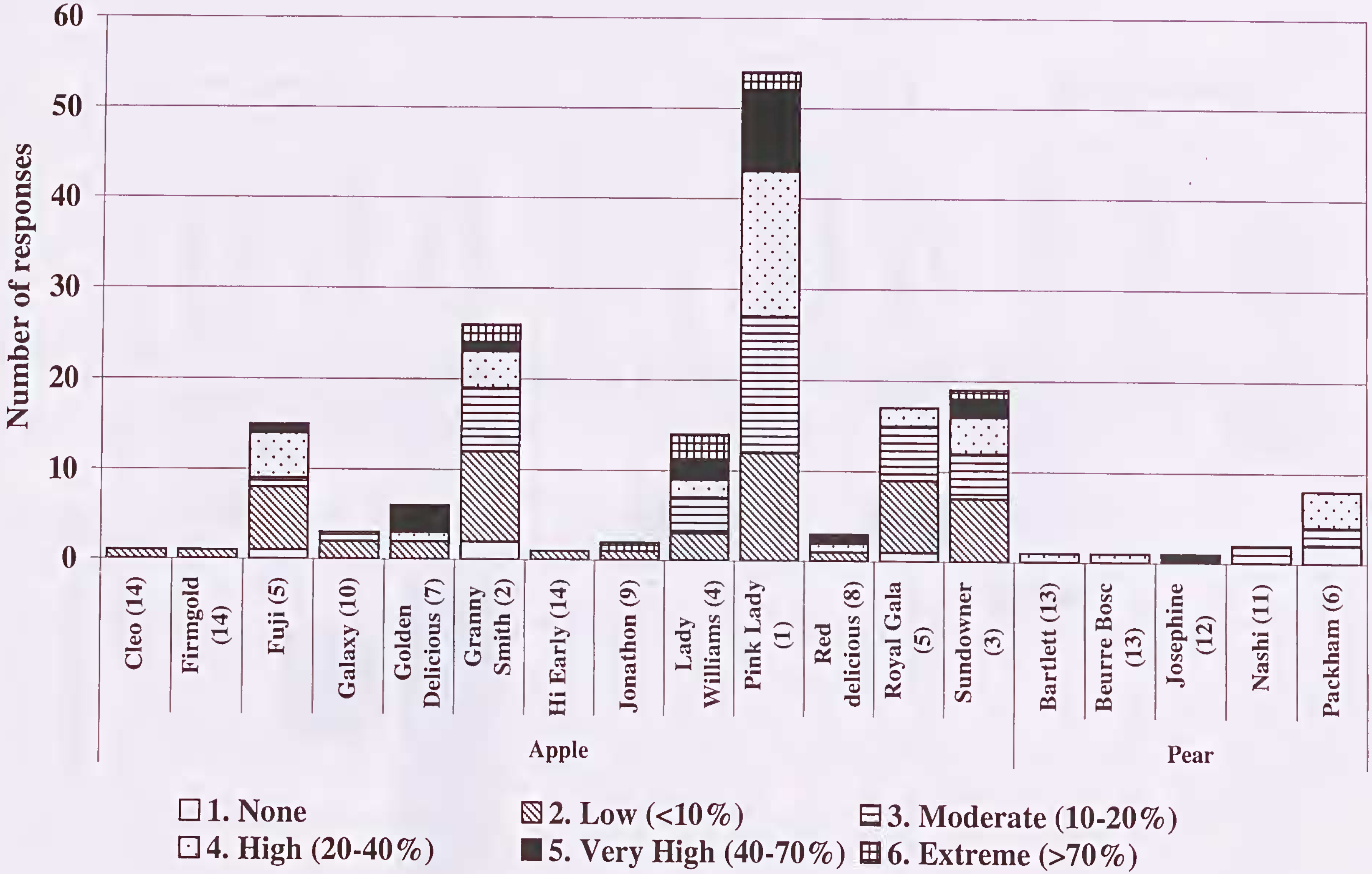

Figure 2. Proportion of fruit damaged by birds for apple and pear crops ($n = 175$). Values in parentheses show ranking for fruit variety by relative extent of damage.

Table 2

Pome fruit orchard parameters and estimate of loss of farmgate income by growers.

	Range	Mean ± s.e.	S.D.	Median	*n*
Orchard size (ha)	0.4 – 50	6.8 ± 1.2	3.8	1	55
Trees per property	9 – 50,000	4,446 ± 977	3,311	500	58
Estimated loss ($)	0 – 150,000	12,453 ± 3,537	25,749	3,000	53

Baudin's Cockatoo was an endangered species in Western Australia and 42% ± 9.1% (n = 81) agreed that it should be protected, even though it damages pome fruit. Most of the growers (94% ± 4.2%, n = 86) had previously incurred fruit damage by Baudin's Cockatoo and 89% ± 5.6% (n = 83) reported that Baudin's Cockatoo had damaged their crop in the previous 12 months.

Fruit value and loss of income

The farmgate value of the fruit in the pome fruit industry in Western Australia during the 2003/2004 season was to $46.79 per tree (Collins *et al.* 2004). Since the mean number of trees per orchard was 4,446 (Table 2), the average farmgate value of the fruit per grower equates to $208,018. The loss of farmgate income due to damage by birds during the 2004/2005 season, as estimated by growers, varied widely from none to $500,000 and averaged $12,453 (Table 2). The average loss equates to 6% of average farmgate income and $1,844 per hectare.

Growers ranked Pink Lady as the most severely damaged variety, followed by Granny Smith, Sundowner and Lady Williams (Figure 2). The most commonly listed damage category was low or less than 10% and 80% of the observations were low, moderate or high (Table 3). Few were very high or extreme (Table 3).

Table 3

Number and proportion of observations of damage to fruit by birds for six categories of damage.

Category	Proportion of fruit lost (%)	Number of Observations	Proportion of observations (%)
None	0	6	3.4
Low	< 10	56	32.0
Moderate	10 – 20	43	24.6
High	20 – 40	41	23.4
Very High	40 – 70	20	11.4
Extreme	> 70	9	5.1
Total		175	100

Table 4

Labour and financial resources dedicated to control of damage to pome fruit crops by birds during the 2004/2005 season.

	Days pest control was undertaken	Hours per day	Cost per hour ($)	Total for pest control last season ($)
Median	80	2	25	3,240
Mean	82.74	2.18	29	5,041
Std. Deviation	51.03	1.94	20	7,351
s.e.	7.22	0.27	2.96	1,084
Minimum	12	0.16	1	200
Maximum	220	10.62	120	45,000
n	50	50	47	46

Damage control

A high proportion of growers (77% ± 7.9%, n = 78) reported that they had previously used pest control to prevent damage by Baudin's Cockatoo. On average, growers estimated that they undertook damage control on 83 days during the 2004/2005 season (Table 4). They estimated that they dedicated around two hours to damage control per day and valued this time at $29 per hour (Table 4). These figures show that growers spent an average of $5,041 on damage control per property (Table 4), which equates to $741 per hectare and represents 2% of farmgate income per property.

The most effective damage control techniques employed by growers were shooting to scare, harassment via motorcycle, harassment via motor vehicle, gas guns and explosive cartridges (Figure 3). Three growers listed shooting to kill as one of their techniques (Figure 3) in a space provided for 'other' techniques, even though this option was not listed on the survey.

Around two-thirds of growers (64% ± 11.2%, n = 56) reported that they had used a combination of control techniques to reduce damage by Baudin's Cockatoo. The most effective combinations of two or three techniques were: gas guns as the primary technique in combination with motor cycle (harassment) and/or shooting to scare; and motor cycle (harassment) as the primary technique, in combination with gas guns and/or shooting to scare (Table 5).

Patterns of Damage

An ANOVA model showed that the proportion of fruit damaged was not related to Shire, the size of the orchard, the number of trees in the orchard or tree density (Table 6). The proportion of fruit damaged was a function of individual property and crop variety (Table 6). Post-hoc analyses of the three most commonly grown varieties showed that damage to Pink Lady was significantly greater than damage to Fuji and Granny Smith.

Discussion

All surveys of damage to fruit by birds have advantages and limitations. Mailed surveys, such as the present one, have the advantage of low cost and wide geographic coverage, but they commonly receive lower response rates than face-to-face interviews and phone interviews (Tracey & Saunders 2003). The limited response rate of 31% to the present survey has the potential to introduce bias into the results, because it is not know if the group that responded was representative of the industry as a whole. However, this can be minimised via the prudent wording of the questions to ensure objectivity (Tracey & Saunders 2003) and by declaring error values to each question, as in this study.

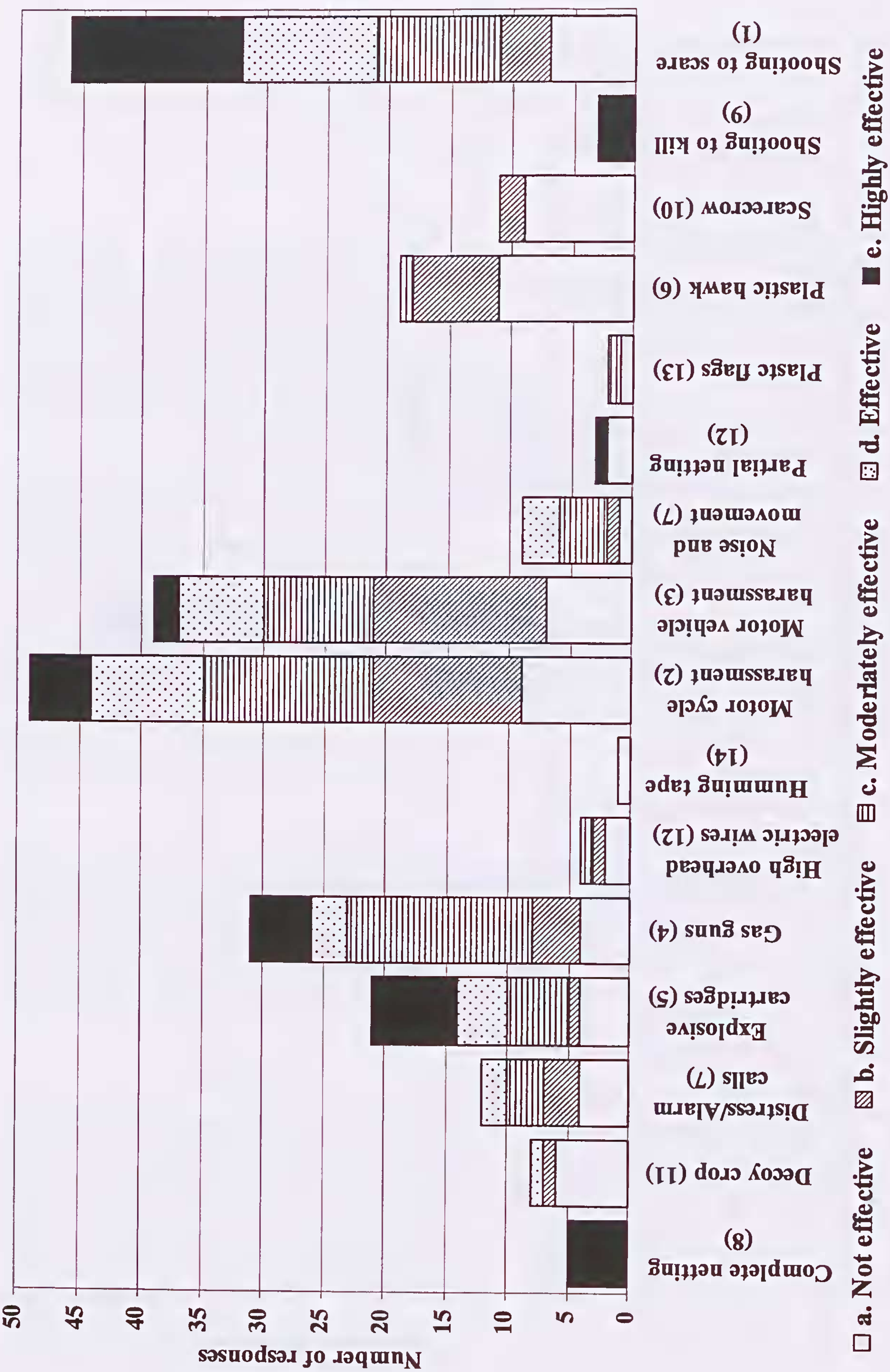

Figure 3. Control techniques for preventing damage to pome fruit by Baudin's Cockatoo (n = 263). Values in parentheses show ranking for technique by relative effectiveness of damage control.

Table 5

Combinations of techniques used to protect pome fruit crops from damage by Baudin's Cockatoo. Rank shows relative effectiveness of 1–7 from most to least effective.

Primary	Second	Third	Rank
Explosive Cartridges	Distress/Alarm calls	Motor Cycle (harassment)	6
	Gas guns	Motor Cycle (harassment)	6
Distress/Alarm calls	Motor Cycle (harassment)	Shooting to scare	7
Gas guns	Explosive Cartridges	Shooting to scare	5
"	Motor Cycle (harassment)	Motor Vehicle (harassment)	5
		Shooting to scare	1
	Shooting to scare	Motor Cycle (harassment)	3
		Motor Vehicle (harassment)	2
Motor Cycle (harassment)	Gas guns	Permanent complete netting structure	3
		Shooting to scare	1
	Motor Vehicle (harassment)	Gas guns	3
	Plastic Hawks	Shooting to scare	6
	Shooting to scare	Explosive Cartridges	3
		Gas guns	4
Motor Vehicle (harassment)	Motor Cycle (harassment)	Gas guns	5
	Shooting to scare	Partial netting	4
Plastic Hawks	Shooting to scare	Motor Cycle (harassment)	5

Table 6

Results of one-way ANOVA examining the relationship between the proportion of fruit damaged and orchard parameters. Significant values are shown in bold.

Parameter	F	d.f.	P
Individual property	6.6	18,52	**< 0.0001**
Shire	0.80	6,52	0.5810
Crop variety	3.04	6,52	**0.0015**
Planting area (ha)	0.38	1,49	0.3588
Number of trees	0.34	1,44	0.5647

Response rates to surveys of fruit damage vary widely (Lim *et al.* 1993, Graham *et al.* 1999, Tracey & Saunders 2003) and reflect monetary losses incurred by growers (Bomford & Sinclair 2002). For example, a survey of bird damage to apples, pears and cherries in the Adelaide Hills recorded response rates of up to 94%, and the proportion of responses directly reflected perceived monetary loss (Graham *et al.* 1999). Assuming the same applies to pome fruit growers in south-west Western Australia, the response rate of 31% to the present survey suggests that fruit damage and monetary loss would be unlikely to be excessive. This was reflected in the low loss of farmgate income and low proportion of fruit damage reported in the survey. The impact of the damage, however, is likely to be a function of the size of the operation i.e. even small losses may have a significant impact on small businesses.

The limited number of growers who returned the survey may also reflect the attitudes of growers toward the cockatoos and perceptions of the level of damage it causes. For example, it may be that the limited response rate reflects antagonism toward the cockatoos and the regulatory authority. The surveys in this study carried the Western Australian Fruit Growers' Association (WAFGA) logo and a Department of Environment & Conservation (DEC) staff member and fruit grower from the local catchments group encouraged growers to return the surveys by collecting them in person. I conclude, therefore, that since the level of damage for survey respondents was low on average and the response rate to the survey was also low, this issue was not a high priority for majority of growers during the 2004/2005 season.

Baudin's Cockatoo was not the only bird pest of pome fruit in Western Australia as other parrots were also nominated as damage causing species. However, this cockatoo does appear to be a common and frequent pest species in and around pome fruit orchards (Long 1985, Halse 1986), since almost all growers had previously incurred damage by Baudin's Cockatoo. Most had also incurred damage during the year leading up to the survey.

Despite the high proportion of growers who's fruit had been damaged by Baudin's Cockatoo, around a quarter of survey respondents had not attempted to prevent or minimise the damage. This suggests damage control is not justified among these growers and there may be a number of reasons for this. Large-scale growers, for example, may be prepared to concede the economic losses of damage by Baudin's Cockatoo because they have large, high value crops that are difficult (or uneconomical) to protect. Another possibility is that this group represents those who rely on shooting and so have not needed to develop a non-lethal damage control program.

Some growers suggested that non-lethal damage control techniques are not cost-effective and/or not effective for protecting pome fruit from damage by Baudin's Cockatoo. However, this view was not supported by the data collected in the survey. On average, growers spent a small proportion of their income on damage control and noise emitting devices were rated as effective or highly effective by growers. Scaring with the use of noise emitting devices, such as gas guns and explosive cartridges, was also identified as an effective deterrent in a previous study (Long *et al.* 1989).

Current best practice for the control of fruit damage by birds involves gaining an understanding of the patterns of damage, assessing the feasibility of control options, implementing a program and monitoring its effectiveness (Braysher 1993, Sinclair 2003). The data collected in this study can be used by growers to develop an effective, efficient damage control strategy for protecting pome fruit from damage by Baudin's Cockatoo. Fruit damage varied significantly between individual properties in the survey and this has also been observed during previous studies (Long 1985). This may be due to a number of factors, such as the variety of fruit grown, proximity to nature reserves, topography and the damage control program employed on individual properties.

One of the key factors accounting for the variation in damage levels appears to be the variety of fruit grown. Pink lady apples were the most commonly and severely damaged fruit variety in this study and a previous study (Halse 1986). Thus, wherever possible, it would be prudent for that all commercial pink lady growers to plan a non-lethal damage control program to protect fruit. Scaring techniques are likely to be effective for preventing fruit damage if used in accordance with current best practice guidelines (Chapman & Massam 2005a, Government of Western Australia 2005). This study showed that combinations of shooting to scare (including explosive cartridges), harassment via motorcycles and gas guns are effective means of reducing damage to pome fruit by Baudin's Cockatoo.

Shooting of Baudin's Cockatoo to protect pome fruit in commercial orchards is unlawful and can-not justified in terms of the damage the cockatoos cause or the costs of damage control to growers. DEC has a legislative responsibility to protect Baudin's Cockatoo from threatening processes and thus, aims to eliminate illegal shooting. WAFGA aims to produce fruit in a sustainable manner and this should apply not only to the use of resources, such as water, but also to the conservation of biodiversity. The use of non-lethal scaring techniques to protect pome fruit from damage by the endangered Baudin's Cockatoo is shown here to be an effective strategy to meet WAFGA's sustainability objectives.

Although most growers who responded to the survey were aware that it is an endangered species, fewer than half agreed that Baudin's Cockatoo should be protected and many called for the cockatoos to be culled in the comments section of the survey. This highlights the need for a strategy to inform growers of why this species is listed as endangered and to demonstrate the extent to which killing the birds to protect fruit threatens the species. An education strategy has now been developed by DEC as part of the recovery program (*e.g.* Chapman & Massam 2005b, Government of Western Australia 2005) and the effectiveness of this strategy will be assessed by DEC as part of the recovery program.

Acknowledgments: The Western Australian Fruitgrowers' Association and staff at the Species and Communities Branch of the Department of Environment and Conservation assisted with the development and mail-out of the surveys. John Tracey, Vertebrate Pest Research Unit, NSW Department of Primary Industries, assisted with the design of the database used to store the survey data. Members of the Warren Catchments Council assisted by prompting growers to return surveys. Matthew Williams assisted with the selection and application of statistical analyses. Peter Mawson and Ken Atkins commented on and made improvements to drafts of the paper.

References

Bomford M & Sinclair R 2002 Australian research on bird pests: impact, management and future directions. Emu 102: 29–45.

Braysher M 1993 Managing vertebrate pests: principles and strategies. Australian Government Printing Service, Canberra.

CALM 2005 Orchardist apprehended for shooting endangered cockatoo. Department of Conservation and Land Management. Media Release 29/04/2005. http://www.naturebase.net/content/view/2032/770/

CALM 2006 Draft Forest Black Cockatoo (Baudin's Cockatoo *Calyptorhynchus baudinii* and Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*) recovery plan 2005–2014. Department of Conservation and Land Management, Perth.

Chapman, T & Massam, M 2005a Scaring and repelling birds to deduce damage. Department of Conservation and Land Management. Fauna Note 02/2005. http://www.naturebase.net/pdf/plants_animals/living_with_wildlife/0205_scaring.pdf

Chapman T & Massam M 2005b Reducing fruit damage by Baudin's cockatoo. Department of Conservation and Land Management. Fauna Note 01/2005. http://www.naturebase.net/pdf/plants_animals/living_with_wildlife/0105_baudins_cockatoo.pdf

Collins D, Cirillo L & Abraham L 2004 (ed) The Australian horticulture statistics handbook 2004. Horticulture Australia Limited, Sydney.

Government of Western Australia 2005 Best practice guidelines for bird scaring in orchards. http://www.naturebase.net/content/view/988/807/

Graham A, Paton D C & Berry O 1999 Survey of the incidence of bird damage to apples, pears, cherries and grapes and methods of control in the Mt Lofty Ranges, South Australia. Final report to the cherry, apple, pear and grape growers of the Mt Lofty Ranges. University of Adelaide, Adelaide.

Halse S A 1986 Parrot damage in apple orchards in south-western Australia – a review. Technical Report Number 8. Department of Conservation and Land Management, Perth.

IUCN 1994 The red list of threatened animals. World Conservation Union, Gland.

Lim T K, Bowman L & Tideman S 1993 A report on the survey of winged vertebrate pest damage on crops in the Northern Territory. Technical Bulletin No. 209. Northern Territory Department of Primary Industries and Fisheries, Darwin.

Long J L 1985 Damage to cultivated fruit by parrots in the south of Western Australia. Australian Wildlife Research 12: 75–80.

Long J L, Mawson P & Littley M 1989 Evaluation of some scaring devices for preventing damage by parrots to cultivated fruit. Technical Series No.5. Agricultural Protection Board, Perth.

Sall J & Lehmann A 1996 JMP Start Statistics. SAS Institute Inc., California.

SAS Institute 1996 JMPIN Version 3.2.1 for Windows. SAS Institute Inc, California.

Saunders D A 1974 Subspeciation in the white-tailed black cockatoo, *Calyptorhynchus baudinii*, in Western Australia. Australian Wildlife Research 1: 55–69.

Sinclair R 2003 Guidelines for best practice bird management. Animal and Plant Control Board, Adelaide.

Tracey J & Saunders G 2003 Bird Damage to the Wine Grape Industry. Report to the Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry. Vertebrate pest research unit, NSW Agriculture.

Whittell H M 1950 Races of the white-tailed cockatoo. Western Australian Naturalist 2: 92.